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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Applicant(s):	Khalil C. Haddad
Case:	1
Serial No.:	09/803,801
Filing Date:	March 12, 2001
Group:	2638
Examiner:	Jason M. Perilla

I hereby certify that this paper is being deposited on this date with the U.S. Postal Service as first class mail addressed to the Commissioner for Patents, P.O. 1450, Alexandria, VA 22313-1450

Signature: Dina Maurice Date: October 21, 2005

Title: Shortening Impulse Response Filter (SIRF) and Design Technique Therefor

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APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant hereby appeals the final rejection dated June 28, 2005, of claims 1-8, 10-16, 18-26, and 28 of the above-identified patent application.

REAL PARTY IN INTEREST

The present application is assigned to Agere Systems Corp., as evidenced by an assignment recorded in the United States Patent and Trademark Office at Reel 011638, Frame 0828, from the Inventors to Agere Systems Guardian Corp., and an assignment under 37 CFR 3.73(b) from Agere Systems Guardian Corp. to Agere Systems Inc., dated April 16, 2003. The assignee, Agere Systems Inc., is the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

STATUS OF CLAIMS

The present application was filed on March 12, 2001 with claims 1 through 28. Claims 9, 17, and 27 were cancelled in the Amendment and Response to Office Action dated September 17, 2004. Claims 1-8, 10-16, 18-26, and 28 are presently pending in the above-identified patent application. Claims 1, 4-6, 10, 11, 14-16, and 18 remain rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor (United States Patent Number 6,396,886; hereinafter "Kapoor") in view of Haddad et al. ("Design of Digital Linear-Phase FIR Crossover Systems of Loudspeakers by the Method of Vector Space Projections," Haddad, Khalil C. et al.; hereinafter "Haddad"), claims 2 and 12 remain rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Shinde (United States Patent Number 6,192,386; hereinafter "Shinde"), claims 19, 22-24, and 28 remain rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Gandhi et al. (United States Patent Number 6,112,218; hereinafter "Gandhi"), claim 20 remains rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, in further view of Gandhi, and in further view of Shinde, claims 1-8, 10-16, and 18 remain rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, Khalil C. ("Constrained FIR Filter Design by the Method of Vector Space Projections," Haddad, Khalil C. et al.; hereinafter "Khalil"), and claims 19-26 and 28 remain rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi.

STATUS OF AMENDMENTS

There have been no amendments filed subsequent to the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention is directed to shortening impulse response filters (SIRF) that satisfy constraints in both the time and frequency domains (page 3, line 23, to page 4, line 25). In addition, methods and apparatus are disclosed for determining the

coefficient values for SIRF filters (page 6, line 15, to page 7, line 13). The disclosed SIRF filters shorten the channel impulse response in the time domain while also providing a frequency response that does not attenuate or amplify the received signal (page 2, lines 20-25). One or more sets define constraints that the SIRF filter must satisfy in the time domain, and one or more sets define constraints that the SIRF filter must satisfy in the frequency domain. By varying the sets utilized to define the time and frequency domain constraints, SIRF filters having a linear or non-linear phase response may be obtained. The intersection of the various sets defines the coefficients for the SIRF filters. Vector space projection methods are utilized to determine the intersection set (page 7, line 14, to page 8, line 7).

STATEMENT OF GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 4-6, 10, 11, 14-16, and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, claims 2 and 12 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Shinde, claims 19, 22-24, and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Gandhi, claim 20 is rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, in further view of Gandhi, and in further view of Shinde, claims 1-8, 10-16, and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and claims 19-26 and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi.

ARGUMENT

Independent Claims 1, 11 and 19

Independent claims 1 and 11 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad and claim 19 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Gandhi. Independent claims 1 and 11 were also rejected under 35 U.S.C.

§103(a) as being unpatentable over Kapoor in view of Khalil, and claim 19 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi. Regarding claim 1, the Examiner asserts that Kapoor discloses establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain (col. 4, lines 10-13; col. 6, lines 58-63). The Examiner further asserts that Haddad teaches that the desired result of the method of using VSPM is the "solution set" or the set that satisfies all the constraints (page 3059, lines 38-42; FIG. 2) and that the VSPM method has significant flexibility in that any number of constraints may be incorporated (page 3063, lines 8-11). Also, regarding claim 1, the Examiner asserts that Khalil teaches an exemplary method of utilizing VSPM methods to determine an intersecting set (FIG. 1) of more than one group of constraints (FIG. 1, refs. C1 and C2; page 715, col. 2, lines 7-12). In the Response to Arguments section of the final Office Action, the Examiner asserts that, as broadly claimed, the set of constraints that the filter must satisfy in the frequency domain is disclosed by Kapoor via the controlling of the frequency spectrum or domain according to the filter coefficients. The Examiner further asserts that both the time domain and frequency domain characteristics of the output of the filter of Kapoor are considered during the determination of the filter's coefficients.

Applicant notes that the concept of sets, intersection of sets and projections are not disclosed or suggested by Kapoor. In SIRF filter design, constraints in the time domain are needed in general to prevent spectral nulls to show up in the solution of the coefficients. Kapoor's method does not introduce sets in the frequency domain; instead Kapoor introduces an artificial noise in the time domain that is added to the cost function in the time domain; therefore, Kapoor puts constraints on the energy of noise and coefficients lumped together in the time domain, and then solves for the coefficients in the time domain. The addition of noise to the cost function to prevent spectral nulls from occurring is a different approach than Haddad's method which relies on adding linear or non-linear constraints in the frequency domain directly to prevent spectral nulls. The method taught by Haddad switches from the time domain to frequency domain (and vice versa) using FFT and IFFT algorithms; the algorithm

disclosed by Kapoor is solved in the time domain only.

Applicant also notes that Khalil was published in August, 2000, and therefore does not constitute prior art under 35 U.S.C. §103(a) since the present application has a filing date of March 12, 2001 (Khalil is incorporated by reference in the present specification). In any case, Khalil is directed to *FIR* filter design and does ***not*** address the design of *SIRF* filters. In addition, the present specification teaches that,

> traditionally, VSPM techniques have been employed to design ***constrained FIR filters*** that are tailored to specific applications. See, K.C. Haddad, "Constrained FIR Filter Design by the Method of Vector Space Projections," IEEE Trans. on Circuit and Systems II: Analog and Digital Signal Processing, Vol. 47, No. 8 (Aug. 2000), incorporated by reference herein. In the context of the present invention, where VSPM techniques are employed to design an ***SIRF** filter, **two (or more) convex sets** representing the constraints in time and frequency domains and corresponding projection operators have been mathematically formulated.* A first convex set defines the constraints that the SIRF filter 120 must satisfy in the time domain, such that when the filter is convolved with the impulse response, the impulse response is shortened. Likewise, a second convex set defines the constraints that the SIRF filter 120 must satisfy in the frequency domain, such as a low, high or band pass band. P_i is defined to be the projection operator onto the set C_i. Thus, to obtain an SIRF filter satisfying both frequency and time constraints, an intersection of both sets is required.
> (Page 4, lines 13-25; emphasis added.)

Khalil does not disclose or suggest ***two (or more) convex sets** representing the constraints in time and frequency domains for SIRF filter design.* Independent claims 1, 11, and 19 require establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

Applicant also notes that Gandhi is directed to a digital filter having a recursive path in which reduced precision adder circuitry can be utilized without increasing quantization error. Gandhi does not address the issue of employing vector

space projection methods to determine intersecting sets.

Thus, Kapoor, Gandhi, Khalil, and Haddad, alone or in any combination, do not disclose or suggest establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods, as required by independent claims 1, 11, and 19.

Additional Cited References

Shinde was also cited by the Examiner for its disclosure of an analogous digital finite impulse response (FIR) filter that does not produce any phase distortion. Applicant notes that Shinde is directed to a digital filter which has a feature of processing by interpolating digital signals x times (col. 1, lines 30-34). Shinde does not address the issue of employing vector space projection methods to determine intersecting sets.

Thus, Shinde does not disclose or suggest establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods, as required by independent claims 1, 11, and 19.

Claims 7 and 25

Claim 7 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Kahlil, and claim 25 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi. Regarding claim 7, the Examiner asserts that Khalil discloses the additional limitations of claim 7 (page 716, col. 1, lines 20-40; col. 2).

Applicants could find no disclosure or suggestion by Khalil that a set of defining constraints that the ***SIRF*** filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length *N* of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_S is the stop-band.

Thus, Kapoor, Gandhi, Haddad, Khalil, and Shinde, alone or in any combination, do not disclose or suggest wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length *N* of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_S is the stop-band, as required by claims 7 and 25.

<u>Claims 8 and 26</u>

Claims 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Kahlil, and claim 26 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi. Regarding claim 8, the Examiner asserts that Khalil discloses the additional limitations of claim 8 (page 716, col. 1, lines 20-40; col. 2).

Applicants could find no disclosure or suggestion by Khalil that a set of defining constraints that the ***SIRF*** filter must satisfy in the frequency domain is defined

as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p . \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s . \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_S is the stop-band, $A(\omega) = \sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude.

Thus, Kapoor, Gandhi, Haddad, Khalil, and Shinde, alone or in any combination, do not disclose or suggest wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p . \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s . \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_S is the stop-band, $A(\omega) = \sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude, as required by claims 8 and 26.

Claims 10, 18, and 28

Claims 10 and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, claim 28 is rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Haddad, and in further view of Gandhi, claims 10 and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Kahlil, and claim 28 is rejected under 35 U.S.C. §103(a) as being unpatentable over Kapoor in view of Khalil, and in further view of Gandhi. Regarding claim 10, the Examiner asserts that Haddad and Khalil disclose that the VSPM method is iteratively applied between the time and frequency domain constraints until the sets converge (FIGS. 1 and 2).

Applicants could find no disclosure or suggestion by Khalil that a vector space projection method is iteratively applied to a set of defining constraints that the ***SIRF*** filter must satisfy in the time domain and the set of defining constraints that the ***SIRF*** filter must satisfy in the frequency domain until the sets converge to a set of coefficients satisfying time domain constraints and frequency domain constraints.

Thus, Kapoor, Gandhi, Haddad, Khalil, and Shinde, alone or in any combination, do not disclose or suggest wherein said vector space projection method is iteratively applied to said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain until the sets converge to a set of coefficients satisfying said time domain constraints and said frequency domain constraints, as required by claims 10, 18, and 25.

Conclusion

The rejections of the independent claims under section 103 in view of Kapoor, Gandhi, Shinde, Khalil, and Haddad, alone or in combination, are therefore believed to be improper and should be withdrawn. The remaining rejected dependent claims are believed allowable for at least the reasons identified above with respect to the independent claims.

The attention of the Examiner and the Appeal Board to this matter is appreciated.

Respectfully,

Kevin M. Mason

Date: October 21, 2005

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APPENDIX

1. A method for determining coefficient values for a shortening impulse response filter (SIRF), said method comprising the steps of:

establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain;

establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and

determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

2. The method according to claim 1, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the time domain define a filter having a linear phase response.

3. The method according to claim 1, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain define a filter having a non-linear phase response.

4. The method according to claim 1, wherein the time domain constraints specify a shortening of a channel impulse response.

5. The method according to claim 1, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

6. The method according to claim 1, wherein the frequency domain constraints include a pass-band for said SIRF filter.

7. The method according to claim 2, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_s is the stop-band.

8. The method according to claim 3, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \ \text{ for } \omega \in \Omega_p. \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s. \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_s is the stop-band, $A(\omega) = \sum_0^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude.

9. (Cancelled)

10. The method according to claim 1, wherein said vector space projection method is iteratively applied to said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain until the sets converge to a set of coefficients satisfying said time domain constraints and said frequency domain constraints.

11. A shortening impulse response filter (SIRF), comprising:

a set of finite impulse response (FIR) coefficients satisfying at least one constraint in a time domain and at least one constraint in a frequency domain, wherein said at least one time domain constraint is represented as at least one first set and wherein said at least one frequency domain constraint is represented as at least one second set, wherein said finite impulse response (FIR) coefficients are determined by an intersecting set of said at least one first set defining said time domain constraints and said at least one second set defining said frequency domain constraints, wherein said intersecting set is determined by employing vector space projection methods.

12. The SIRF according to claim 11, wherein said at least one first set defining constraints that said SIRF filter must satisfy in a time domain define a filter having a linear phase response.

13. The SIRF according to claim 11, wherein said at least one second set defining constraints that said SIRF filter must satisfy in a frequency domain define a filter having a non-linear phase response.

14. The SIRF according to claim 11, wherein the time domain constraints specify a shortening of a channel impulse response.

15. The SIRF according to claim 11, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

16. The SIRF according to claim 11, wherein the frequency domain constraints include a pass-band for said SIRF filter.

17. (Cancelled)

18. The SIRF according to claim 11, wherein said vector space projection method is iteratively applied to said at least one first set defining said time domain constraints and said at least one second set defining said frequency domain constraints until the sets converge to a set of coefficients satisfying said time domain constraints and said frequency domain constraints.

19. A system for determining coefficient values for a shortening impulse response filter (SIRF), said system comprising:

a memory that stores computer-readable code; and

a processor operatively coupled to said memory, said processor configured to implement said computer-readable code, said computer-readable code configured to:

establish at least one set of defining constraints that said SIRF filter must satisfy in a time domain;

establish at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and

determine an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

20. The system according to claim 19, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the time domain define a filter having a linear phase response.

21. The system according to claim 19, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain define a filter having a non-linear phase response.

22. The system according to claim 19, wherein the time domain constraints specify a shortening of a channel impulse response.

23. The system according to claim 19, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

24. The system according to claim 19, wherein the frequency domain constraints include a pass-band for said SIRF filter.

25. The system according to claim 20, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_s is the stop-band.

26. The system according to claim 21, wherein said at least one set of defining said domain constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p. \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s. \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_S is the stop-band, $A(\omega) = \sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude.

27. (Cancelled)

28. The system according to claim 19, wherein said vector space projection method is iteratively applied to said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain until the set of defining constraints that said SIRF filter must satisfy in the time domain converge to a set of coefficients satisfying said time domain constraints and the set of defining constraints that said SIRF filter must satisfy in the frequency domain converge to a set of coefficients satisfying said frequency domain constraints.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to § 1.130, 1.131, or 1.132 or entered by the Examiner and relied upon by appellant.

RELATED PROCEEDINGS APPENDIX

There are no known decisions rendered by a court or the Board in any proceeding identified pursuant to paragraph (c)(1)(ii) of 37 CFR 41.37.